Welsh Government

M4 Corridor around Newport

Environmental Statement Volume 3: Appendix 2.2

Drainage Strategy Report

M4CaN-DJV-HDG-ZG_GEN-RP-CD-0001

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1 The Project

1.1 Context

1.1.1 The Welsh Government has awarded a Professional Services Contract for the next stage of Scheme development and environmental surveys for the M4 Corridor around Newport (M4CAN) up to publication of draft Orders and an Environmental Statement. The contract has been awarded to a Joint Venture of Costain, Vinci and Taylor Woodrow with consultants Arup and Atkins, supported by sub-consultant RPS. The team shall be developing proposals in anticipation of publishing draft Orders and an Environmental Statement in spring 2016 and a Public Local Inquiry later that year. This process will then inform the next stage of Ministerial decision making.

1.1.2 Since 1989 there have been various studies to identify the problems and propose possible solutions. The M4 Corridor around Newport WelTAG Stage 1 (Strategy Level) Appraisal concluded that a new section of 3-lane motorway to the south of Newport following a protected (TR111) route, in addition to complementary measures, would best achieve the goals and address the problems of the M4 Corridor around Newport and should be progressed for further appraisal. These options have subsequently formed the basis for the development of the draft Plan, which was published in September 2013 and was the subject of public consultation from September to December 2013.

1.1.3 Having taken into account the responses to this participation process, as well as the assessments of the draft Plan, the Welsh Government has decided to publish a Plan for the M4 Corridor around Newport. Alongside this Plan, the Welsh Government has published updated strategy-level reports, including a Strategic Environmental Assessment Statement, to demonstrate how the participation process has informed its decision making. It also announced in July 2014 a revised preferred route, which will protect a corridor for planning purposes. These documents can be accessed from the website http://m4newport.com.

1.2 Scheme objectives and reason for the scheme

1.2.1 The aims of the Welsh Government for the M4 Corridor around Newport are to:

a) Make it easier and safer for people to access their homes, workplaces and services by walking, cycling, public transport or road.

b) Deliver a more efficient and sustainable transport network supporting and encouraging long-term prosperity in the region, across Wales, and enabling access to international markets.

c) To produce positive effects overall on people and the environment, making a positive contribution to the over-arching Welsh Government goals to reduce greenhouse gas emissions and to making Wales more resilient to the effects of climate change.

1.2.2 The Scheme aims to help to achieve or facilitate these aims as part of a wider transport strategy for South East Wales, as outlined within the Prioritised National Transport Plan.

1.2.3 The Transport Planning Objectives (TPOs), or goals, are:

TPO 1: Safer, easier and more reliable travel east-west in South Wales.

TPO 2: Improved transport connections within Wales and to England, the Republic of Ireland and the rest of Europe on all modes on the international transport network.

TPO 3: More effective and integrated use of alternatives to the M4, including other parts of the transport network and other modes of transport for local and strategic journeys around Newport.

TPO 4: Best possible use of the existing M4, local road network and other transport networks.

TPO 5: More reliable journey times along the M4 Corridor.

TPO 6: Increased level of choice for all people making journeys within the transport Corridor by all modes between Magor and Castleton, commensurate with demand for alternatives.

TPO 7: Improved safety on the M4 Corridor between Magor and Castleton.

TPO 8: Improved air quality in areas next to the M4 around Newport.

TPO 9: Reduced disturbance to people from high noise levels, from all transport modes and traffic within the M4 Corridor.

TPO 10: Reduced greenhouse gas emissions per vehicle and/or person kilometre.

TPO 11: Improved travel experience into South Wales along the M4 Corridor.

TPO 12: An M4 attractive for strategic journeys that discourages local traffic use.

TPO 13: Improved traffic management in and around Newport on the M4 Corridor.

TPO 14: Easier access to local key services and residential and commercial centres.

TPO 15: A cultural shift in travel behaviour towards more sustainable choices.

1.2.4 The scheme-specific environmental objectives (EO), as set out in the Strategic Environmental Assessment of the Plan, are as follows:

EO1 - Improved air quality in areas next to the existing M4 around Newport;

EO2a - Reduce greenhouse gas emissions per vehicle and/or person kilometre;

EO2b - Ensure that effective adaptation measures to climate change are in place;

EO3 - Reduce disturbance to people from high noise levels, from all transport modes and traffic within the existing M4 Corridor;

EO4 - Ensure that biodiversity is protected, valued and enhanced;

EO5 - Improved access to all services and facilities and reduce severance;

EO6 - Protect and promote everyone's physical and mental wellbeing and safety;

EO7 - Reduce transport related contamination and safeguard soil function, quality and quantity;

EO8 - Minimise transport related effects on surface and groundwater quality, flood plains and areas of flood risk;

EO9 - Ensure the prudent and sustainable use of natural resources and energy;

EO10 - Ensure that diversity, local distinctiveness and cultural heritage are valued, protected, celebrated and enhanced;

EO11 - Ensure that landscape and townscape is properly valued, conserved and enhanced;

1.2.5 In addition, the Wales Transport Strategy includes the following environmental outcomes (WTSEO):

Outcome 11: The sustainability of the transport infrastructure - Increase the use of more sustainable materials in our country's transport assets and infrastructure;

Outcome 12: Greenhouse gas emissions - Reduce the impact of transport on greenhouse gas emissions;

Outcome 13: Adapting to climate change - Adapt to the impacts of climate change;

Outcome 14: Air pollution and other harmful emissions - Reduce the contribution of transport to air pollution and other harmful emissions;

Outcome 15: The local environment - Improve the positive impact of transport on the local environment;

Outcome 16: Our heritage - Improve the effect of transport on our heritage;

Outcome 17: Biodiversity - Improve the impact of transport on biodiversity.

2 Scope of this Report

2.1.1 The scope of this report is the drainage strategy for the proposed highway.

2.1.2 This report informs how the Scheme would deliver principally on the following Scheme objectives: Transport Planning Objectives 1 and 7; Environmental Objectives Wales 2b, 4 and 8, Transport Strategy Environmental Outcomes 13 and 17.

3 Basis of Assessment

3.1.1 Following consultations and reviews undertaken previously, a set of design criteria for the drainage design has been developed which aims to promote sustainable drainage and meet the requirements of Natural Resources Wales (NRW), South Wales Trunk Road Agency (SWTRA) and the Design Manual for Roads and Bridges (DMRB) guidelines. These reflect the unique hydrological environment of the Gwent Levels, through which the M4 Corridor around Newport would pass.

3.1.2 Consultation is currently being held with NRW and SWTRA, and the drainage strategy is subject to their approval.

4 Carriageway Drainage, Basic Spillage Control and Water Treatment

4.1.1 For the majority of its length, the proposed Scheme is located within the Gwent Levels. Typical ground conditions comprise very soft sub-soils with a very high water table. In order to minimise settlement, impact upon the ground water level and visual intrusion, it is proposed to maintain a low level embankment on which the new section of motorway is constructed. Discharge to lined drainage channels will be adopted because a conventional gulley and pipe drainage system would require longitudinal falls which could only be created by raising the embankment.

4.1.2 In addition, the adopted strategy requires the surface water run-off, after attenuation and treatment, to discharge to the major NRW reens where there is a greater flow of water. This will either be directly by pipe or by the addition of engineered field ditches, which would discharge to the main reens.

4.1.3 It is proposed to intercept the run-off from the new section of motorway into grassed channels in the verge. These are trapezoidal shaped are typically 2.1m wide, widening to 3.0m wide x 0.8m deep near outfall points. Side slopes would be 1 in 1.5. These route surface water overland from the drained carriageway to the water treatment areas. When the carriageway is super elevated in the central reserve of the motorway, the introduction of concrete barriers and maintenance restrictions excludes the use of grassed channels. Here concrete channels will be utilised.

4.1.4 The grassed channels will be dry during dry weather, enhancing their pollutant removal capability, but during a rainfall event the water will flow into them from the carriageway and move slowly to the outfall point. The flow of water will be retarded and filtered by the grass. Sediment will be deposited and oily residues and organic matter retained and broken down in the top layer of soil and vegetation. During a rainfall event, a proportion of the run-off may be lost due to evaporation and transpiration. The use of grassed channels has been identified as a means of reducing pollution and promoting a more sustainable drainage system compared to conventional drainage systems.

4.1.5 The grassed channels will follow the gradient of the new section of motorway, typically 1 in 7,000 through the Levels. It is anticipated that they would be lined with a geo-synthetic clay liner below 50mm of topsoil. This eliminates the risk of

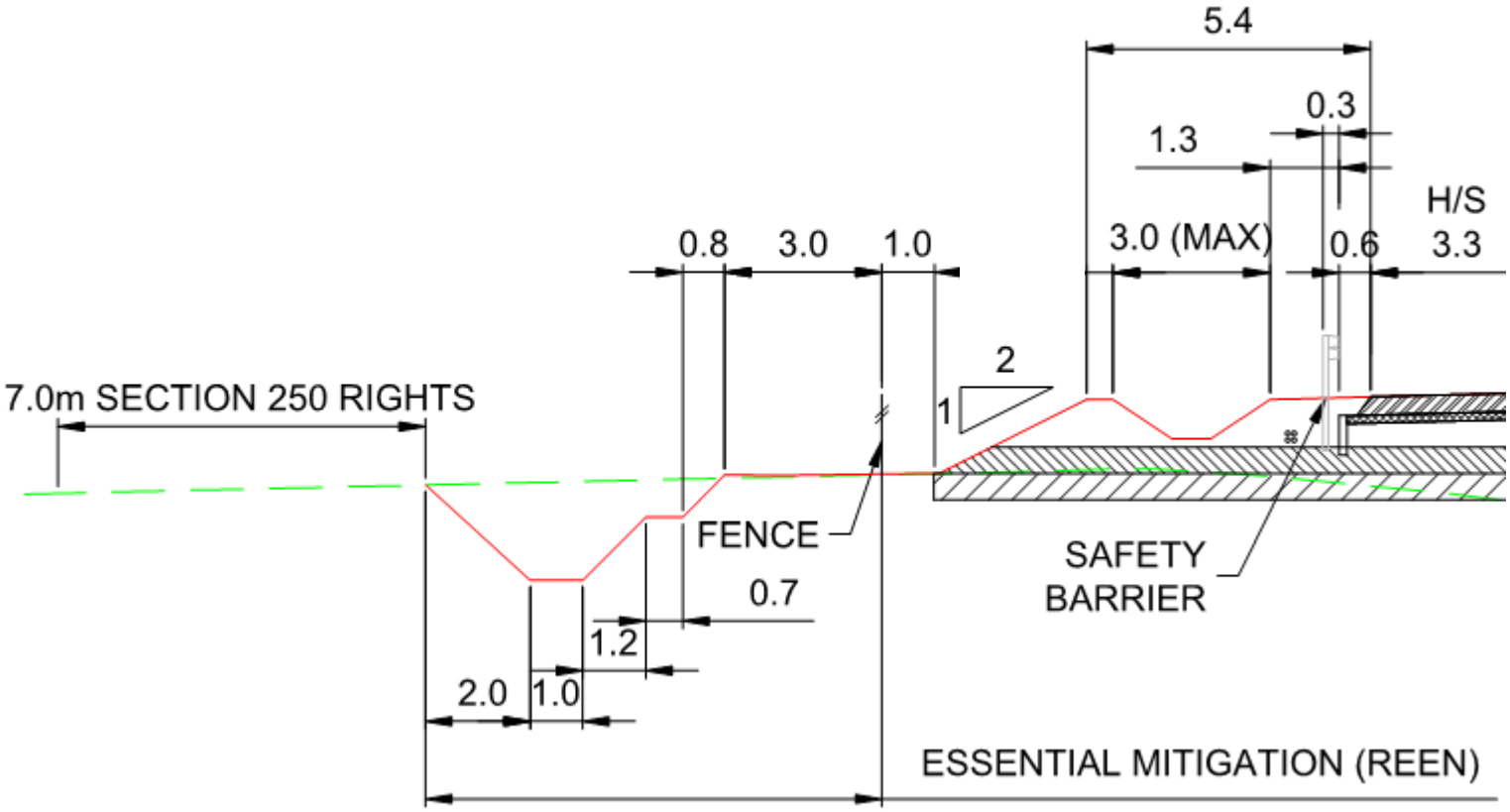
surface water run-off containing possible pollutants seeping into the underlying ground.

4.1.6 The very flat longitudinal gradients across the Gwent Levels would exclude the use of kerb and gully and a piped drainage system because the longitudinal falls necessary for this system could not be achieved in an efficient way.

4.1.7 SWTRA have proposed that they would maintain the grassed channels using self-propelled or remote control mowers. These would require cutting 3 times a year in late spring and summer. Grass length should not be longer than 75mm, in accordance with DMRB HA 119/06.

4.1.8 The grassed channels within the SSSI are currently proposed to cater for a 1 in 100 year storm event with allowance for climate change. Substantial storms in excess of this return period event would overflow over the highway embankment into the adjacent field reens, but it is considered that a storm intensity of this magnitude would dilute any pollutants to acceptable levels, and that the statistical probability of the storm occurring is very low. A typical section of the road across the Levels is shown in Figure 1 overleaf.

Figure 1: Typical section of highway across the Gwent Levels



4.1.9 The run-off in the grassed channels will be captured in collection sumps and routed to the water treatment areas, see Figure 2 (in Appendix A).

4.1.10 From the sumps the water would flow into the water treatment and attenuation areas. They will include the provision to capture hydrocarbons and grits prior to flows entering the main attenuation lagoons.

4.1.11 Where the highway alignment dictates that steeper falls are introduced or the carriageway drains to the median, conventional drainage will be used, typically concrete surface water channels.

4.1.12 All drainage from the new section of motorway will be designed to capture run-off from the carriageway for all events up to the 1% (1 in 100 year) AEP rainfall event with the addition of a 30% allowance for climate change.

4.1.13 With the exception of discharges to the River Usk and the River Ebbw, all drainage will be treated through 15 Water Treatment Areas. These areas are listed below in Table 1.

4.1.14 When flows enter the WTA they first pass through a forebay area before entering the main attenuation lagoon. The forebay contains systems which are designed to retain a minimum of 50 cubic metres of oil/hydrocarbon.

4.1.15 The main attenuation lagoon has been designed to restrict flow to the equivalent 'greenfield runoff' within the Gwent Levels. The attenuated flow from the lagoon is trickle fed through a reed bed for final polishing and treatment before discharging into either replacement reens or the main reen system.

4.1.16 Water quality at the outfalls from the water treatment areas will be of a quality and quantity to enable these parts of the drainage system to support the SSSI features. Further details of the water quality strategy for the Scheme are provided in the Environmental Statement Appendix 16.3.

4.1.17 For outfalls to the River Usk and River Ebbw, there is no requirement for flow attenuation as the flows outfall to a tidal river. Pollution control will be provided by oil separators. These will be either baffle arrangements within open lagoons or within bespoke underground units.

4.1.18 For side roads where there is no increase in impermeable area, existing outfalls will be utilised.

4.1.19 For side roads where impermeable areas are increased and new junctions, outfalls will include pollution protection using oil separators and attenuation lagoons. These outfalls are outlined below in Table 2.

Table 1: Outfall Details

Outfall no.	Receiving Watercourse	Estimated Highway runoff storage volume required (m^3)	Attenuated Discharge rate (l/s)	Contributing Impermeable Area (Ha)
1	Pwll Bargoed Reen	9000	32.5	9.3
2	Tyn-y-Brwyn Reen	10500	40.1	11.5
3	Outfall to Newport County Council (NCC) drainage network without attenuation (Existing or modified side roads only). No motorway drainage to be discharged to the NCC system and overall contributing areas will be reduced.			
4a	Percoed Branch East	4200	15	4.3
4b	Percoed Branch East	4200	15	4.2
5	Morfa Gronw Reen	7000	25.6	7.3
6	Lakes Reen	4000	16.8	4.8
7	Julians Reen	3600	14.4	4.1
8	Ellen Reen	8400	31.5	9
8a	Black Wall Reen	3500	3.5	1
9	Middle Road Reen Diversion	13000	55.3	15.8
10	Rush Wall South Reen	2700	11.6	3.3
11b	St Bride's Brook	7950	17.7	6
11c	St Bride's Brook	5100	17.6	5
12a	Prat Reen	18000	50.5	14.4
12b	Vurlong Reen	675	2.6	0.73

Table 2 – Side Roads and Main river outfalls

Receiving Watercourse	Estimated Highway runoff storage volume required (m^3)	Attenuated Discharge rate (l/s)	Contributing Impermeable Area (Ha)
Ebbw West Outfall	N/A	N/A	1.3
Ebbw East Outfall (inc. SDR link)	N/A	N/A	11
Usk Outfall	N/A	N/A	2.9
Meadows Road North	350	1.2	0.34
Meadows Road South	350	1.2	0.34
North Row North	350	1.1	0.31
North Row South	350	1.2	0.34

4.1.20 Fin drains will be installed along the edge of carriageway between the edge of pavement and the safety barriers. These will run for 200m before discharging into a 1050mm dia type 7 catchpit which outfalls into the replacement reen or field ditch at the toe of the embankment or to the granular drainage blanket below the road formation.

5 Median Drainage

5.1.1 Over some stretches of the new section of motorway, the road will be super elevated and drainage to the median channel is required. The central reserve will be hardstanding, with a concrete vertical concrete barrier, and as described earlier, a concrete channel is used.

5.1.2 The size of the channel is limited by the amount of space available in the central reserve. Generally this is 1.5m, however as a result of widening for visibility on some curved sections the size may vary. The depth of the channel is limited to 0.15m as this is the largest allowable depth which is not required to have a barrier between the channel and the road edge.

6 Attenuation Lagoons and Embankment Height (Across the Gwent Levels)

6.1.1 Each attenuation lagoon is designed to cater for a 1 in 100 year storm event with an allowance for climate change. Historically, the greenfield runoff rate has been restricted to 3.5l/s/Ha as set by the NRW. During meetings during Key Stage 3, NRW have stated that this value is appropriate for the design.

6.1.2 In order to minimise the height of the motorway embankment, the flood storage variation in the lagoons is generally limited at 1.1m, with a minimum of 0.2m freeboard above this. The outfalls from the lagoons discharge into a reen at or above the Summer Penning Level (SPL). The SPL for each reen is set by the NRW and is unique to each reen. Although the water level in the reens can rise occasionally above the summer penning levels, a flap valve at the outfall pipe will ensure that the water from the reen does not flow into the lagoon.

6.1.3 The height of the highway embankment is dependent on the following factors at each outfall:

- Crossfall in Carriageway
- Depth of grassed channels/concrete channel
- Cover depth to pipe crossing carriageway
- Pipe diameter to the water treatment area
- Fall due to pipe gradient, grit trap, petrol interceptor, spillage lagoon, reed beds.
- Attenuation depth in lagoon
- Summer penning level in the reen

6.1.4 Based on these factors, the minimum embankment height across the Levels will be some 2.1m above the SPL.

6.1.5 It is anticipated that fencing would be provided to each water treatment area to prevent/restrict access to the ponds and lagoons.

Typical layout of the water treatment areas is shown in Figure 2, see Appendix A.

7 Cross Flow Culverts

7.1.1 The culverts beneath the proposed motorway embankment with discernible catchments will be designed to cater for the 1 in 100 year storm events including climate change allowance. In all, assessment of the reen system indicates that a total of 37 culverts are required across the levels to culvert the major reens. Details of the primary culverts are shown in Table 3. Bed levels are subject to the results of detailed survey, which could increase the culvert sizes to allow sufficient freeboard.

Table 3 Culvert details

Structure No.	Culverted Watercourse	Bed Level (m AOD)	WPL (m AOD)	SPL (m AOD)	Chainage	Nearest Structure
SMN 0510	Nant-y-Moor Reen (extension of existing)	3.71	4.25	4.7	5+100	W56
SMN 0550	SDR Reen Culvert	4.31	4.65	5	5+500	W50
SBR 0570	Percoed Reen	4.31	4.65	5	5+850	W50
SMN 0680	Morfa Gronw Reen	3.9	5.55	5.55	6+900	W69
SMN 0770	Old Dairy Reen Field Access Culvert	4.1	5.77	5.82	7+700	W73
SMN 0775	Old Dairy Reen	4.1	5.77	5.82	7+750	W73
SMN 0800	Pont-y-Cwcw Reen	4.8	5.70	6.00	7+990	W81
SMN 0805	Replacement Reen Pont-y-Cwcw	4.8	5.7	6.000	8+050	W81
SBR 0835	Sea Wall Reen	TBC	TBC	TBC	8+380	N/A
SMN 0905	Maes-Glas Pill	TBC	TBC	TBC	9+050	N/A
SMN 1180	Picked Lane Culvert	TBC	TBC	TBC	11+800	N/A
SMN 1230	Lakes Reen	3.895	4.70	5.30	12+350	C01
SMN 1235	Lake's Reen North Access Culvert	3.895	4.70	5.30	12+350	C01
SMN 1240	Julian's Reen Side Road	3.895	4.70	5.30	12+450	C01

Structure No.	Culverted Watercourse	Bed Level (m AOD)	WPL (m AOD)	SPL (m AOD)	Chainage	Nearest Structure
SMN 1250	Julian's Reen Farm Access Culvert	3.895	4.70	5.30	12+500	C01
SMN 1300	Julian's Reen	3.895	4.70	5.30	13+000	C01
SMN 1305	Tatton Farm Access	3.895	4.7	5.30	13+050	C01
SMN 1310	Julian's Reen Access Track Culvert	3.895	4.7	5.30	13+050	C01
SMN 1330	Tatton Farm Culvert	4.00	4.23	4.5	13+300	N/A
SMN 1350	Field Culvert	4.00	4.23	4.5	13+550	N/A
SMN 1430	Ellen Reen	3.61	4.23	4.5	13+900	C23
SMN 1445	Ellen Reen Diversion Track Culvert	3.61	4.23	4.5	14+400	C23
SMN 1475	Glan Llyn Link SAR Ditch	TBC	TBC	TBC	14+800	N/A
SMN 1480	Black Wall Reen	3.50	4.23	4.50	14+890	C23
SBR 1480	Monk's Ditch	4.35	4.00	5.30	14+900	N/A
SBR 1640	Steelworks Dedicated Reen	1.25	-	-	15+750	N/A
SMN 1655	Elver Pill Reen	3.785	4.26	4.5	16+650	C35
SMN 1720	New Cut Reen	2.965	4.1	4.45	17+200	C62
SMN 1750	North Row SAR Ditch Culvert	TBC	TBC	TBC	17+500	N/A
SBR 1755	North Row Middle Road Reen (North)	2.965	4.1	4.45	17+550	C62
SBR 1770	North Row Middle Road Diversion Reen (South)	2.965	4.1	4.45	17+800	C62
SBR 1780	Mainline Middle Road Diversion Reen	2.965	4.1	4.45	17+900	C62
SMN 1850	Cock Street Reen	3.00	3.60	4.30	19+250	N/A

Structure No.	Culverted Watercourse	Bed Level (m AOD)	WPL (m AOD)	SPL (m AOD)	Chainage	Nearest Structure
SMN 1925	Petty Reen	3.00	3.60	4.30	19+250	N/A
SMN 1940	Rush Wall Reen Culvert	3.00	3.60	4.30	19+275	N/A
SMN 1970	Bareland Street East North Culvert	TBC	TBC	TBC	19+700	N/A
SMN 1980	Bareland Street East South Culvert	TBC	TBC	TBC	19+750	N/A

7.1.2 The majority of the reens to be culverted have only a small catchment and a box culvert, sufficient to cater for the flows and provide sufficient head room for maintenance will be provided.

7.1.3 The culverts will be sufficiently large to allow man entry for maintenance purposes. The culverts are to be designed to allow the invert level to be placed at a minimum of 150mm below the bed level of the reens being culverted. In addition, a minimum of 200mm free board is allowed above the summer penning level of the reens. Mammal crossings will be provided independently to the hydraulic culverts. The mammal crossings will be 900mm dia pipes which will be positioned with the invert above the SPL.

7.1.4 In addition to the primary culverts, a number of secondary culverts will be required. These include culverts for access tracks for water treatment areas, culverts to take runoff from cut off ditches, and to allow connectivity of field ditches. These have not been included in the list above as details of these will be developed during detailed design. They will be Category 0 structures.

7.1.5 The crossflow culverts are generally located perpendicular to the motorway, permitting the shortest length of culvert. This also allows the existing flows in the reens to be maintained while the culvert is constructed off-line.

7.1.6 The culverts consist of pre-cast concrete sections, generally 2.0m in length. They will either be piled or will be constructed on a granular bed which has been laid on the alluvium beneath. A geotextile membrane ensures that the granular bed does not penetrate the alluvium. The ground will be surcharged prior to the culvert being constructed in order to minimise movement in the culvert sections once construction is complete.

7.1.7 In-situ or precast concrete headwalls are constructed at each end of the culvert and the reens diverted into the culverts. The construction of the culverts and headwalls off-line will minimise the disruption to the reens. Penstock valves will be included on the end of each headwall to enable the culvert to be isolated for maintenance access.

8 Embankment Toe/Reen Drainage

8.1.1 Reens are generally provided on the north side of the new section of motorway to provide improved connectivity with the cross flow culverts. NRW recommended that these reens are excavated to a depth of 2.0m with 1 in 1 side slopes, a 0.7m berm and are approximately 5.7m wide at the surface. The total length of replacement reens and field ditches will be equal or greater than the reens and field ditches to be infilled.

8.1.2 On the south side, smaller field ditches will be used to connect the existing field ditches to the nearest main reens. NRW recommended that these are 2.5m wide with 1 in 1 slopes and 1m deep.

8.1.3 It is proposed to provide means of regulating flows at the head and outflow of the cross flow culverts. This would allow the regulation of water level and flow along the entire length of the motorway corridor. In addition, the sluices can be utilised when maintaining the reens and culverts by diverting flows from one catchment to another. This arrangement will provide maximum flexibility in supplying water across the Gwent Levels.

8.1.4 Further detailed information on the reen proposals is provided in the Reen Mitigation Strategy file note (M4CaN-DJV-HDG-ZG_GEN-FN-CD-0002).

9 River Usk crossing drainage

9.1.1 The drainage on the River Usk crossing will consist of kerb drainage out falling to a pipe that runs along the central reservation. Kerb drainage will be present on the central reservation and the westbound carriageway, as the deck is super elevated along its length. The diameter of the pipe varies along its length, reaching a maximum internal diameter of 750mm. Connections from kerb drainage in the westbound carriageway will occur at 100m intervals.

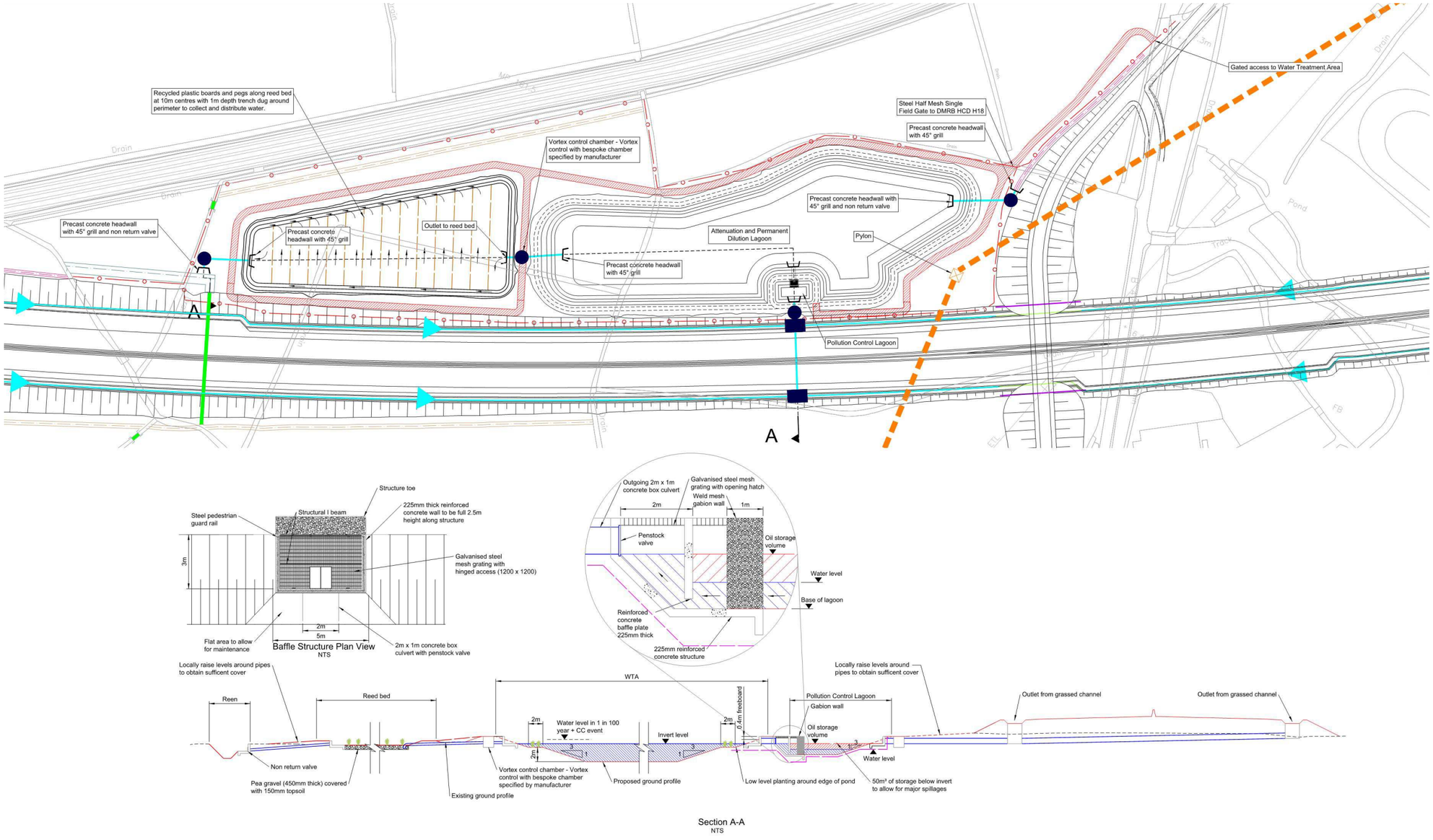
9.1.2 On the west side of the River Usk crossing, drainage will discharge into the River Ebbw via an oil separator. An attenuation lagoon will not be required as the River Ebbw is tidal at this point, and is not impacted by additional fluvial flows.

9.1.3 On the east side of the River Usk the drainage will outfall into the River Usk via a small storage lagoon and a field ditch. The lagoon is provided to store surface water run-off during periods when the outfall is surcharged by tide levels in the estuary. The pond also has the ability to retain hydrocarbon spillages using baffle plates at the outfall.

Appendix A

Figure 2 – Water Treatment Area layout

A1 Figure 2



Legend

- Dilution volume for contaminants
- Impermeable LLDPE Geomembrane 1mm thick between two layers of PP nonwoven geotextile pond liner. Need for liner below reed bed and lagoon to be confirmed with Environment and Geotechnical input. Liner will be required below pollution control lagoon.
- Grassed channel
- Culvert
- Headwall
- Access Track — Surface course - 300mm thick Type 1 subbase; Base course - 300mm thick capping; Geotextile membrane in base; Assumes CBR of 2%
- Replacement reen
- Replacement field ditch
- Cut off ditch
- Post and 4 rail fence with 50 x 50mm steel galvanised mesh on outside
- Manhole
- Intake chamber